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MORBIDITY AND MORTALITY IN US NAVY PERSONNEL FROM EXPOSURES TO HAZARDOUS MATERIALS, 1974-85

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Morbidity and Mortality in US Navy Personnel From Exposures to Hazardous Materials, 1974-85

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This study was undertaken as part of an overall program to reduce the use of hazardous materials aboard ship. The objective of this study was to identify the morbidity and mortality among Navy enlisted personnel resulting from exposures to these materials. All hospitalizations and deaths occurring as a result of exposures to these compounds were examined with respect to duty station, age, race, sex, length of service, and ship type. A total of 1,371 hospitalizations and 136 deaths occurred in U.S. Navy enlisted personnel from January 1, 1974 to December 31, 1985. Exposures to various gas fumes and vapors accounted for the largest percentage of all hospitalizations (38%), and the second largest percentage of deaths (20.6%). The most frequent cause of death was from carbon monoxide poisoning, nearly 74% of all reported deaths were attributed to this gas. Hospitalization rates were highest among the 17 to 19 -year olds across all race categories. The Navy occupations showing the highest risk for various exposures to hazardous materials were Utilitiesman, Hull Maintenance Technicians, and Boatswain's Mate.

The Occupational Safety and Health (OSH) Act of 1970 requires all employers to maintain a safe and healthful work environment for their employees. OPNAVINST 5100.23B for forces afloat and OPNAVINST 5100.19B for forces ashore implements the Navy's OSH program which places emphasis on the abatement of hazardous materials. The Navy is currently developing a program (NAVSUPINST 5100.27) to reduce the quantity and toxicity of hazardous materials (HM) now in use (1). The Naval Sea Systems Command Ship Design and Engineering Directorate (NAVSEA 05) has initiated a plan to meet this objective. The purpose of this program is to identify HM of high risk to personnel, and substitute safer materials whenever possible.

Hospitalizations and deaths, as well as administrative actions resulting from Medical and Physical Evaluation Boards that are related to exposure to HM, can be determined from Medical and Service History files maintained at the Naval Health Research Center (NHRC). Although specific data on the compounds which caused the injuries incurred is not contained on our Medical files, there is information on the type of hazardous materials by general category of compounds, such as petroleum products, industrial solvents, gas fumes or vapors etc. In addition, potential risk factors can be examined using information on duty station, age, race, sex, length of service, occupation, and ship type derived from our Service History files.

The objective of this study is to use the NHRC Medical and Service History files to identify the morbidity and mortality experiences among Navy enlisted personnel which have resulted from exposure to hazardous materials. To the degree that the population at risk and the nature of hazardous exposures can be identified, strategies for reducing the health hazards associated with these materials can be developed.

Methods

The numerator data for illness rates is drawn from the computerized Inpatient Follow-up Data System containing all hospitalizations, deaths, and Medical and Physical Evaluation Board findings for all active duty enlisted personnel for the period 1965 to 1985. This file is maintained at NHRC and has been generated from data provided annually by the Naval Medical Data Services Center in Bethesda, Maryland. Population data is compiled from files supplied by the Naval Military Personnel Command (NMPC) four times each year. NHRC receives these files from NMPC to generate population counts by demographic characteristics, occupation, and service history variables. For this investigation medical and service history data were extracted for the period 1974 to 1985.

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Shown in Table 1 are those NHRC diagnostic codes for toxic exposures, along with their equivalent International Classification of Diseases, Ninth Revision (ICD-9) codes (3). Cases included all enlisted personnel who were hospitalized or who died as a result of their exposures to any of these materials during the period January 1, 1974 to December 31, 1985. A total of 1,371 hospitalizations were identified from our inpatient medical history files during this 12-year period. Age-specific and age-adjusted hospitalization rates for all enlisted active-duty navy personnel (5,029,368 person-years), were calculated and compared to the total navy population. Standardized Morbidity Ratios (SMRs) along with 95% confidence limits were calculated for all navy occupations having at least one reported case of a hospitalization or death resulting from exposure to these materials. Age-adjustment was done using the indirect method, a technique selected because the number of cases in some categories were not sufficient enough to provide the stability of rates appropriate for the use of direct age-adjustment (4). Age-adjusted rates were computed in order to remove the effect of any age differences among the various groups being compared. Ninety-five percent confidence limits were calculated assuming the Poisson distribution which is often used to model the occurrence of rare events (5). In this study the occurrence of a hospitalization due to an exposure to a hazardous material was considered a rare event.

Results

Hospitalization rates per 10,000 person-years from exposures to hazardous materials occurring from 1974 to 1985 are shown in Table 2 by year and sex. There has been a similar pattern in males and females over this 12-year time period. Hospitalization rates for males range from a high of 4.0 per 10,000 person-years in 1977 to a low of 1.6 in 1984. Females also show their highest rate of 5.8 in 1977 and their lowest rate of 0.5 in 1984. A total of 1,301 hospitalizations occurred in males during this 12-year period for an average annual rate of 2.6 per 10,000 person-years at risk. Females were hospitalized 70 times during this same period for an average annual rate of 2.1

Age and race-specific average annual hospitalization rates for males are shown in Table 3. The age group at highest risk is the 17-19 year old for all race categories. The race category showing the highest rate for this age group is "Other," (12.4 per 10,000 person-years), which includes American Indian, Filipino, and Oriental, followed by a rate of 4.0 for Whites, and a rate of 2.5 for Blacks. There appears to be a general downward trend in hospitalization rates with respect to age across all race categories. The overall average annual hospitalization rate is 6.5 for "Other," 2.6 for Whites, and 1.7 for Blacks. Table 4 shows a similar finding for females

Table 1

Internationa Classification of Diseases, 9th Revision (ICD-9) and Naval Health Research Center (NHRC) diagnostic codes for toxic exposures

Diagnoses	ICD-9	NHRC codes
Toxic effect petroleum products	981	921
Toxic effect industrial solvents	982	922
Toxic effect corrosive aromatic-acid, caustic alkaloids	983	923
Toxic effect of lead and its compounds, including fumes	984	924
Toxic effects other metal non-medicinal	985	925
Toxic effect other metals	- -	926
Toxic effect arsenic, antimony, and their compounds	- -	927
Toxic effect from simple organic substances	- -	928
Toxic effect of mercury and its compounds	- -	929
Toxic effect of lead and its compounds, not including fumes	- -	930
Toxic effect of carbon monoxide	986	931
Toxic effect of other gas fumes or vapors	987	932
Toxic effect of noxious foodstuff	988	933
Toxic effect of substances non-medicinal	989	934
Toxic effect of economic poisons	-	936

Table 2

Hospitalization rates per 10,000 person-years as a result of exposures to hazardous materials, by year and sex, Navy active-duty enlisted personnel, 1974-85

Year	Population at risk		Number of hospitalizations		Hospitalization rates	
	Male	Female	Male	Female	Male	Females
1974	463,901	12,992	148	1	3.2	0.8
1975	429,384	16,895	126	3	3.0	1.8
1976	413,326	18,703	127	5	3.2	2.7
1977	408,792	18,856	153	11	4.0	5.8
1978	409,121	20,013	123	3	3.1	1.5
1979	404,662	23,341	109	7	2.9	3.0
1980	402,083	28,206	67	8	1.9	2.8
1981	408,510	32,474	84	9	2.3	2.8
1982	414,606	35,992	96	9	2.5	2.5
1983	425,377	38,913	101	8	2.6	2.1
1984	430,492	40,562	65	2	1.6	0.5
1985	419,114	42,792	102	4	2.4	0.9
Total	5,029,368	329,739	1,301	70	2.6	2.1

Table 3

Average-annual hospitalization rates per 10,000 person-years as a result of exposures to hazardous materials, by age and race, Navy active-duty enlisted male personnel, 1974-85

Age group	White		Black		Other	
	Population at risk	Rate	Population at risk	Rate	Population at risk	Rate
17-19	745,916	[illegible]	89,067	2.5	4,023	12.4
20-24	1,925,484	[illegible]	263,845	1.7	17,375	10.4
25-29	758,680	2.2	107,872	1.6	15,379	3.2
30-34	482,648	1.3	48,749	1.4	10,047	3.0
35-39	373,621	1.7	31,118	1.3	7,825	6.4
40-44	107,434	1.3	10,343	0.0	3,928	7.6
45-49	28,368	2.1	2,409	0.0	1,062	0.0
50-61	9,106	0.0	358	0.0	128	0.0
Total	4,431,257	2.6	553,761	1.7*	59,767	6.5†

* Significantly lower than the total U.S. Navy rate of 2.6 per 10,000 person-years at risk in male enlisted personnel

† Significantly higher than the total U.S. Navy rate of 2.6 per 10,000 person-years at risk in male enlisted personnel

with race "Other" showing the highest rate of 3.8, followed by a rate of 2.2 for Whites, and a rate of 1.4 in Blacks.

Although a large part of the data concerning route of exposure is missing on our Medical History Files (39.5%), it is clear from Table 5 that poisoning by inhalation was responsible for the largest number of reported cases, 32.7%. Poisoning by ingestion accounted for 26.5% of the cases, and poisoning by contact accounted for only 1.3%, nearly 40% of the cases had "other" or missing data.

Frequency and percent distribution of hospitalizations as a result of exposures to HMs by place of injury is shown in Table 6. Onshore at unspecified sites accounted for the majority of cases, 58.1%, aboard ships represented 19.8%, and home quarters or on-base accounted for 12.5%. The remaining cases occurred at airfields, industrial plants, dock facilities, aboard aircraft, and 4.8% of the cases occurred at unknown locations.

Looking at hospitalization rates by three general categories of ships, show Carriers to have the highest rate of 1.6 per 10,000 person-years, followed by Submarines with a rate of 1.3, and other Surface Ships with the lowest rate of 1.1 (Table 7). The total hospitalization rate for exposure to HMs while occurring aboard ships of all types was 1.2 compared with 3.6 for exposures occurring onshore; this difference was statistically significant ($p<.001$).

The most common category of compounds responsible for the largest number of hospitalizations is gas fumes or vapors which are responsible for approximately 36% of all hospitalizations (Table 8). This category includes gas fumes or vapors such as liquefied petroleum gases, other hydrocarbon gases (acetylene, methane, etc.), nitrogen and sulfur dioxide, freons etc. Not included are lead or carbon monoxide which each have their own ICD-9 and NHRC codes. The second most common cause is substances non-medicinal 30.2%, which would include materials like cyanide, hydrocyanic acid, and brucine, and third is carbon monoxide with 10.9%.

Shown in Table 9 is the percent distribution of hospitalizations as a result of exposures to HMs which occurred either aboard ships or at "other" locations". Of the 272 hospitalizations occurring

Table 4

Average-annual hospitalization rates per 10,000 person-years as a result of exposures to hazardous materials, female enlisted Navy personnel, 1975-85

Females	Population at risk	No. of cases	Hospitalization rate
White	276,406	62	2.2
Black	50,739	7	1.4
Other	2,597	1	3.8
Total	329,742	70	2.1

Table 5

Frequency and percent distribution of hospitalization as a result of exposures to hazardous materials, by route of exposure, Navy active-dute enlisted personnel, 1975-85

Route of exposure	Frequency	Percent
Poisoning by inhalation	448	32.7
Poisoning by ingestion	363	26.5
Poisoning by contact	18	1.3
Other or missing	542	39.5
Total	1,371	100.0

Table 6

Frequency and percent distribution of hospitalization as a result of exposures to hazardous materials, by place of injury, Navy active-duty enlisted personnel, 1975-85

Place of injury	Frequency	Percent
Onshore unspecified	797	58.1
Aboard ship	272	19.8
Home quarters or base	172	12.5
Onshore airfield	20	1.5
Industrial plant	19	1.4
Onshore dock facility	18	1.3
Onboard aircraft	7	0.5
Unknown	66	4.8
Total	1,371	100.0

Table 7

Hospitalization rates per 10,000 person-years as a result of exposures to hazardous materials, by ship type, Navy active-duty enlisted male personnel, 1975-85

Ship type	No. of hospitalizations	Population at risk	Hospitalization rate
Carriers	66	423,216	1.6
Submarines	32	241,137	1.3
Other surface ships	168	1,502,792	1.1
Shipboard*	266	2,167,145	1.2
Shore†	1035	2,862,223	3.6
Total	1,301	5,029,368	2.6

*Significantly lower than the total U.S. Navy rate of 2.6 per 10,000 person-years at risk in male enlisted personnel
†Significantly higher than the total U.S. Navy rate of 2.6 per 10,000 person-years at risk in male enlisted personnel

while aboard ship, 70.2% were a result of exposures to gas fumes or vapors, 14.3% for substances non-medicinal, and 5.1% for industrial solvents. At "other locations," only 27.3% of the hospitalizations were attributed to gas fumes or vapors, while substances non-medicinal represented the largest proportion of cases with 34.1%, and carbon monoxide third with 12.6%. Thirteen persons died as a result of their exposures to these materials while aboard ship, and 123 fatalities were reported to have occurred at "other locations".

Table 10 summarizes the categories of hazardous materials responsible for the largest number of hospitalizations which occurred either on Carriers, Submarines, or other Surface Ships. Gas fumes or vapors accounted for the largest number of cases across all three groups of ships, followed by substances non-medicinal.

Percent distribution of hospitalization and death as a result of exposures to HMs is shown in Table 11. Carbon monoxide was responsible for 73.5% of all deaths reported, but only 4.3% of the hospitalizations. The second most common cause of death was a result of exposure to gas fumes or vapors which accounted for 20.6%, then substances non-medicinal 3.7%, and lastly, industrial solvents were responsible for 2.2%. Percent distribution of deaths occurring while aboard ships show that gas fumes

Table 8

Frequency and percent distribution of hospitalization as a result of exposures to hazardous materials, Navy active-dute enlisted personnel, 1975-85

Hazardous material	Frequency	Percent
Gas fumes or vapors	491	35.8
Substances non-medicinal	414	30.2
Carbon monoxide	150	10.9
Corrosive agents	69	5.0
Industrial solvents	52	3.8
Petroleum products	47	3.4
Noxious foods	47	3.4
Other metals non-medicinal	34	2.5
Lead, including fumes	1	0.1
Unknown	66	4.8
Total*	1,371	100.0

* Includes 136 persons who died as a result of their exposures to these materials

Table 9

Percent distribution of hospitalization as a result of exposures to hazardous materials which occurred either aboard ship or at other locations, Navy active-duty enlisted personnel, 1974-85

Hazardous material	Onboard Ship* Percent (No.)	Other Locations† Percent (No.)
Gas fumes or vapors	70.2 (191)	27.3 (300)
Substances non-medicinal	14.3 (39)	34.1 (375)
Industrial solvents	5.1 (14)	3.4 (38)
Carbon monoxide	4.0 (11)	12.6 (139)
Corrosive agents	2.2 (6)	5.7 (63)
Petroleum products	1.5 (4)	3.9 (43)
Noxious foods	1.1 (3)	4.0 (44)
Other metals non-medicinal	1.5 (4)	2.7 (30)
Lead, including fumes	0.0 (0)	0.1 (1)
Unknown	0.0 (0)	6.0 (66)
Total	100.0 (272)	100.0 (1099)

* Includes 13 persons who died as a result of their exposure to these materials
† Includes 123 persons who died as a result of their exposure to these materials

Table 10

Percent distribution of hospitalization per 10,000 person-years as a result of exposures to hazardous materials which occurred aboard ship, by ship type, Navy active-duty enlisted personnel, 1974-85

Hazardous material	Carriers	Submarines	Other Surface ships
Gas fumes or vapors	66.7 (44)	93.5 (29)	67.4 (118)
Substances non-medicinal	18.2 (12)	6.5 (2)	14.9 (26)
Industrial solvents	3.0 (2)	0.0 (0)	7.1 (12)
Carbon monoxide	7.6 (5)	0.0 (0)	3.6 (6)
Corrosive agents	1.5 (1)	0.0 (0)	2.4 (4)
Petroleum products	1.5 (1)	0.0 (0)	1.8 (3)
Other metals non-medicinal	0.0 (0)	0.0 (0)	2.4 (4)
Noxious foods	1.5 (1)	0.0 (0)	1.2 (2)
Total	100.0 (66)	100.0 (31)	100.0 (175)

Table 11

Percent distribution of hospitalization and death as a result of exposures to hazardous materials , Navy active-duty enlisted personnel, 1974-85

Hazardous material	Hospitalization Percent (No.)	Death Percent (No.)
Gas fumes or vapors	38.4 (474)	20.6 (28)
Substances non-medicinal	36.4 (449)	3.7 (5)
Corrosive agents	5.8 (72)	0.0 (0)
Petroleum products	4.0 (50)	0.0 (0)
Noxious foods	3.9 (48)	0.0 (0)
Carbon monoxide	4.3 (53)	73.5 (100)
Industrial solvents	4.1 (51)	2.2 (3)
Other metals non-medicinal	3.0 (37)	0.0 (0)
Lead, including fumes	0.1 (1)	0.0 (0)
Total	100.0 (1235)	100.0 (136)

or vapors were responsible for 46.2% of all reported deaths, carbon monoxide 38.5%, and industrial solvents and substances non-medicinal each representing 7.7% of the reported fatalities (Table 12).

Total number of days hospitalized as a result of exposure to these materials was 6,685 days. Approximately 75% were hospitalized for 3 days or less, and only 3.2% were hospitalized for more than 3 weeks (Table 13).

Standardized morbidity ratios (SMRs) with 95% confidence limits for males are summarized in Table 14 for those occupations having statistically significant SMRs (see Appendix for remaining occupations). The standard population used to calculate the SMRs was the total U.S. Navy male population which had been hospitalized as a result of exposures to HMs during the time period from January 1, 1974 to December 31, 1985. Standardized morbidity ratios for females were not calculated because of their small sample size. The 3 occupations showing the highest SMR were Utilitiesman with a SMR of 4.2, followed by Hull Maintenance Technician 3.0, and then Boatswain's Mate with a SMR of 2.2.

Table 12

Frequency and percent distribution of deaths as a result of exposures to hazardous materials occurring while aboard ship, Navy active-duty enlisted personnel, 1975-85

Hazardous material	Frequency	Percent
Gas fumes or vapors	6	46.2
Carbon monoxide	5	38.4
Industrial solvents	1	7.7
Other substances non-medicinal	1	7.7
Total	13	100.0

Table 13

Frequency and percent distribution of the number of days hospitalized as a result of exposures to hazardous materials, Navy active-duty enlisted personnel, 1974-1985

Numbers of days hospitalized	Frequency	Percent	Cumulative Percent
Less than 1 day	98	7.9	7.9
1 day	484	39.2	47.1
2 days	238	19.3	66.4
3 days	103	8.3	74.7
4 days	58	4.7	79.4
5 days	43	3.1	82.9
6 to 10 days	84	6.1	89.7
11 to 20 days	59	4.8	94.5
21 to 35 days	28	2.3	96.8
Greater than 35 days	40	3.2	100.0

Total number of person-days hospitalized = 6,685

Table 14

Standardardized morbidity ratios (SMRs) with 95 percent confidence limits for hospitalizations as a result of exposures to hazardous materials by occupation, male active-duty enlisted Navy personnel, 1974-85

Occupation	No. of cases	Person-years	SMR (95% C.L.) *Standard Pop.
Utilitiesman	15	14,645	4.22 (2.36, 6.96)
Hull Maintenance Tech	90	119,775	3.00 (2.41, 3.69)
Boatswain's Mate	44	94,585	2.21 (1.61, 2.97)
Hospital Recruit	102	204,580	2.04 (1.67, 2.48)
Engineman	43	87,146	1.99 (1.44, 2.68)
Aviation Boatswain's Mate	31	61,554	1.98 (1.35, 2.82)
Torpedoman's Mate	18	42,804	1.75 (1.04, 2.77)

* Standard population used was the total U.S. Navy male population which was hospitalized as a result of exposures to hazardous materials from 1974 to 1985. The above 7 occupations showed statistically significant SMRs ($p < 0.05$).

Discussion

This study was undertaken as part of an overall program to reduce the use of hazardous materials aboard ship. These results have provided specific data on the magnitude of the problem in terms of mortality and morbidity as well as providing a profile of the subpopulations which appear to have an increased risk of exposure to these compounds. These data in combination with other findings can be used to formulate an explicit policy on the control and management of hazardous materials.

To determine the health hazards associated with these materials, all hospitalizations and deaths occurring as a result of exposures to these compounds were examined with respect to duty station, age, race, sex, length of service, and by ship type. A total of 1,371 hospitalizations and 136 deaths occurred in U.S. Navy enlisted personnel from January 1, 1974 to December 31, 1985. The average annual hospitalization rate for males was 2.6 per 10,000 person-years, and for females it was 2.1 per 10,000 person-years.

Gas fumes or vapors which would include a large number of compounds such as liquefied petroleum gases, other hydrocarbon gases (acetylene, methane, etc.), nitrogen and sulfur dioxide, freons etc., accounted for the largest percentage of all hospitalizations (38%), and the second largest percentage of deaths (20.6%). The most frequent cause of death was from carbon monoxide poisoning; nearly 74% of all reported deaths were attributed to this gas. It is the inhalation of these compounds which poses the greatest health risk to personnel both onshore and aboard ships.

The age group at highest risk for hospitalizations from exposures to HM are the 17 to 19 year olds. This may be attributed either to their lack of experience and knowledge concerning the safe handling of these materials, or perhaps a disproportionate number of 17 to 19 year olds are given tasks which put them at higher risk.

Approximately 80% of all the accidental exposures occurred while ashore at various locations, the remaining 20% occurred aboard ship. Shipboard hospitalization rates were very similar for Aircraft Carriers, Submarines, and other Surface Ships. Overall hospitalization rates for shipboard accidents was 1.2 per 10,000 person-years, compared to 3.6 for shore accidents. Of the 272 hospitalizations which occurred aboard ship, 70.2% were a result of inhalation of various gas fumes or vapors. This is in contrast to the 27.3% attributed to exposure to gas fumes or vapors occurring while onshore. Shipboard work environments tend to be more confining and less well ventilated than comparable work environments ashore, this may account for the observed difference between these two work environments.

The Navy occupations at highest risk for various exposures to HM are Utilitiesman, Hull Maintenance Technicians, and Boatswain's Mate. Utilitiesman commonly work with plumbing, heating, steam, compressed air, and fuel storage and distribution systems. Hull Maintenance Technicians typically work with welding, hot and cold forming of metals, and maintenance and repair of valves, piping, and plumbing systems, while Boatswain's Mate are involved with keeping the outside surfaces of ships in good condition, maintaining machinery and equipment on ships' decks and handling various types of cargo (6).

Because inhalation of various gas fumes or vapors poses the greatest health risks to individuals working with such compounds, emphasis needs to be placed on the potential risks involved when working with volatile compounds, particularly in poorly ventilated areas. Individuals who appear to be especially vulnerable are the 17 to 19 year olds, who either through their lack of experience or knowledge are at the highest risks of an accident resulting from exposures to hazardous materials. Those potential situations where carbon monoxide gas may be present pose the greatest risk to life; 100 of the 136 reported deaths were attributed to carbon monoxide poisoning.

Considering the greater risk posed by gas fumes and vapors to shipboard crews in comparison to shore based crews, additional training on the risk such hazards present should be considered. Furthermore, it may be particularly effective if such training were focused on the young crew members who appear to be at highest risk. Finally, these data suggest that the reduction in the number of compounds which are a potential inhalation hazard should be assigned the highest priority in the effort to limit hazardous materials aboard ship.

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Appendix

Master-at-Arms (SMR=2.0, 0.4 - 5.8), Quartermaster (SMR=1.1, 0.6 - 1.9), Signalman (SMR=0.9, 0.4 - 1.9), Operations Specialist (SMR=1.1, 0.7 - 1.6), Electronics Warfare Technician (SMR=1.2, 0.4 - 2.6), Sonar Technician (SMR=0.6, 0.3 - 1.0), Ocean System Technician (SMR=0.4, 0.0 - 2.0), Gunners Mate (SMR=1.3, 0.8 - 1.9), Fireman (SMR=0.8, 0.5 - 1.3), Missile Technician (SMR=1.3, 0.5 - 2.8), Mineman (SMR=0.7, 0.0 - 4.0), Electrician Technician (SMR=0.5, 0.4 - 0.8), Data System Technician (SMR=0.8, 0.3 - 2.0), Instrumentmen (SMR=0.9, 0.0 - 5.1), Opticalman (SMR=1.2, 0.0 - 6.9), Navy Counselor (SMR=2.3, 0.6 - 5.8), Radioman (SMR=0.6, 0.4 - 0.9), Cryptologic Technician (SMR=0.5, 0.3 - 1.0), Yeoman (SMR=0.4, 0.2 - 0.8), Personnelman (SMR=0.5, 0.2 - 1.1), Data Processing Technician (SMR=0.7, 0.2 - 1.7), Storekeeper (SMR=1.2,).8 - 1.9), Disbursing Clerk (SMR=0.6, 0.1 - 2.0), Mess Management Specialist (SMR=1.2, 0.8 - 1.7), Ships Servicemen (SMR=1.5, 0.9 - 2.5), Journalist (SMR=2.6, 0.7 - 6.7), Lithographer (SMR=3.1, 0.6 - 9.0), Illustration Draftsman (SMR=1.5, 0.0 - 8.4), Seamen Recruit (SMR=0.8, 0.7 - 0.9), Machinistmate (SMR=1.1, 0.9 - 1.4), Machinery Repairmen (SMR=1.2, 0.5 - 2.4), Boiler Technician (SMR=1.4, 1.0 - 1.8), Electricians Mate (SMR=1.2, 0.9 - 1.7), Interior Communication Electrician (SMR=0.9, 0.5 - 1.5), Gas Turbine System Technician (SMR=1.6, 0.4 - 4.1), Patternmaker (SMR=2.7, 0.1 - 15.0), Fireman Recruit (SMR=0.7, 0.6 - 1.0), Construction Electrician (SMR=0.9, 0.2 - 2.5), Equipment Operator (SMR=1.2, 0.5 - 2.4), Construction Mechanic (SMR=1.7, 0.7 - 3.6), Builder (SMR=1.2, 0.6 - 2.4), Steelworker (SMR=1.6, 0.4 - 4.1), Avionics Technician (SMR=2.5, 0.1 - 14.1), Aviation Mechanic Technician (SMR=1.3, 0.9 - 1.8), Aviation Electronics Technician (SMR=0.8, 0.5 - 1.3), Antisubmarine Warfare Technician (SMR=0.4, 0.0 - 1.5), Aviation ASW Operator (SMR=0.6, 0.2 - 1.5), Aviation Ordnanceman (SMR=1.1, 0.6 - 1.8), Aviation Fire Control (SMR=0.6, 0.2 - 1.5), Air Controlman (SMR=0.7, 0.2 - 1.9), Aviation Electrician Mate (SMR=0.6, 0.3 - 1.1), Aviation Structural Mechanic (SMR=1.3, 0.9 - 1.7), Aircrew Survival Equipmentmen (SMR=0.9, 0.2 - 2.3), Aerographers Mate (SMR=1.4, 0.5 - 3.4), Tradevman (SMR=0.3, 0.0 - 1.4), Aviation Storekeeper (SMR=1.2, 0.5 - 2.3), Aviation Maintenance Administrator (SMR=0.9, 0.3 - 2.0), Aviation Support Equipmentmen (SMR=1.6, 0.7 - 3.1), Photographer Mate (SMR=1.1, 0.3 - 2.5), Airman Recruit (SMR=0.8, 0.6 - 1.1), Dentalman (SMR=0.8, 0.2 - 1.8)

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This study was undertaken as part of an overall program to reduce the use of hazardous materials aboard ship. The objective of this study was to identify the morbidity and mortality among Navy enlisted personnel resulting from exposures to these materials. All hospitalizations and deaths occurring as a result of exposures to these compounds were examined with respect to duty station, age, race, sex, length of service, and ship type. A total of 1,371 hospitalizations and 136 deaths occurred in U.S. Navy enlisted personnel from January 1, 1974 to December 31, 1985. Exposures to various gas fumes and vapors accounted for the largest percentage of all hospitalizations (38%), and the second largest percentage of deaths (20.6%). The greatest cause of death was from carbon monoxide poisoning, nearly 74% of all reported deaths were attributed to this gas. Hospitalization rates were highest among the 17 to 19-year olds across all race categories. The Navy occupations showing the highest risk for various exposures to hazardous materials were Utilitiesman, Hull Maintenance Technicians, and Boatswain's Mate.

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